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Proposed Repairs to the Tongue River Dam

Draft Enviromental Impact Statement

October 1974

Prepared by:
Montana Department of Natural
Resources & Conservation
Water Resources Division

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October 1, 1974

Following is the Draft Environmental Impact Statement for a planned repair effort upon the Tongue River Dam. This action is proposed by the Water Resources Division, Department of Natural Resources and Conservation (Department).

I would encourage you to carefully review this statement and invite your response. Any written comments should be submitted to me by October 30, 1974. Upon request, we will grant a fifteen-day extension of the above-noted deadline. In the event a final impact statement is preapred, written comments will be included.

This Draft Environmental Impact Statement was prepared in compliance with the Montana Environmental Policy Act, Section 69-6504(b) (3), and was submitted to the Environmental Quality Council on October 1, 1974.

Sincerely,

Gerhard M. Knudsen

GERHARD M. KNUDSEN
ENVIRONMENTAL COORDINATOR

GMK/sl

Enclosures

DRAFT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED REPAIRS
TO THE
TONGUE RIVER DAM

Prepared by

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
WATER RESOURCES DIVISION

Submitted Pursuant to:

Montana Environmental Policy Act
Section 69-6504(b)(3)

October, 1974

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I. INTRODUCTION

The Tongue River Project is a dam and storage reservoir about ten miles north of the Montana-Wyoming state line near Decker in Big Horn County, Montana (see Figure 1). Construction of the project, which was financed with a loan and grant from the Public Works Administration and funds of the State Water Conservation Board, predecessor of the Department, was completed in 1940 to provide a reliable source of irrigation water for users downstream of the site. In addition to its agricultural benefits, the reservoir also receives considerable recreational use, and water has been sold for industrial purposes.

The Tongue River Water Users' Association operates the dam only. All of the users divert their water with private diversions from the Tongue River. Current contracts for agricultural use of water involve 35,835 acre feet* per year, and there is an option on 4,175 acre feet of water for industrial use. Currently 127 contracts are held by 72 individuals, including two agencies, the U.S. Department of the Interior and the State Board of Examiners. The estimated firm annual yield on this project is 40,000 acre feet.

The dam consists of 1,224,000 cubic yards of earth fill with a 350 foot wide, 60,000 cfs capacity concrete emergency spillway. The structure, 1,824 feet long and 91 feet high, has a storage capacity of 69,439 acre feet and floods a maximum area of 3,497 acres. The reservoir pool area as well as 2,326 acres of land surrounding the impoundment are deeded to the state.

Figures 2 and 3 show the normal path of the water from the reservoir through the dam to the river channel. The flow of water from the tunnel is regulated with an operating gate which is raised and lowered with cables attached to pulleys and motors at the top of the control tower. The gate house shown on Figure 3 is situated at the top of the tower. An emergency gate, just upstream from the operating gate, is used if repairs to the operating gate are required or the operating gate is unusable for some reason. If the inflow to the reservoir is greater than the capacity of the tunnel, the reservoir may fill and water subsequently flows over the emergency spillway. This has rarely occurred since the dam was constructed.

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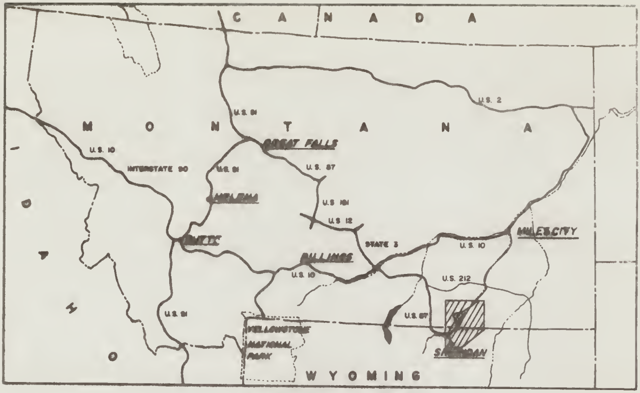
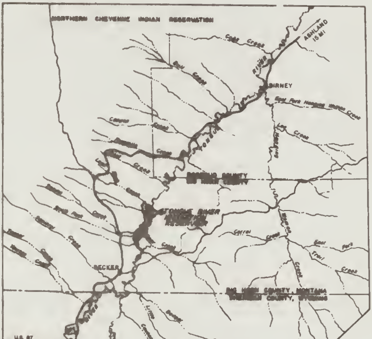
* An acre-foot covers one acre of land to a depth of one foot. One acre-foot of water can supply the domestic needs of a family of 5 for one year.

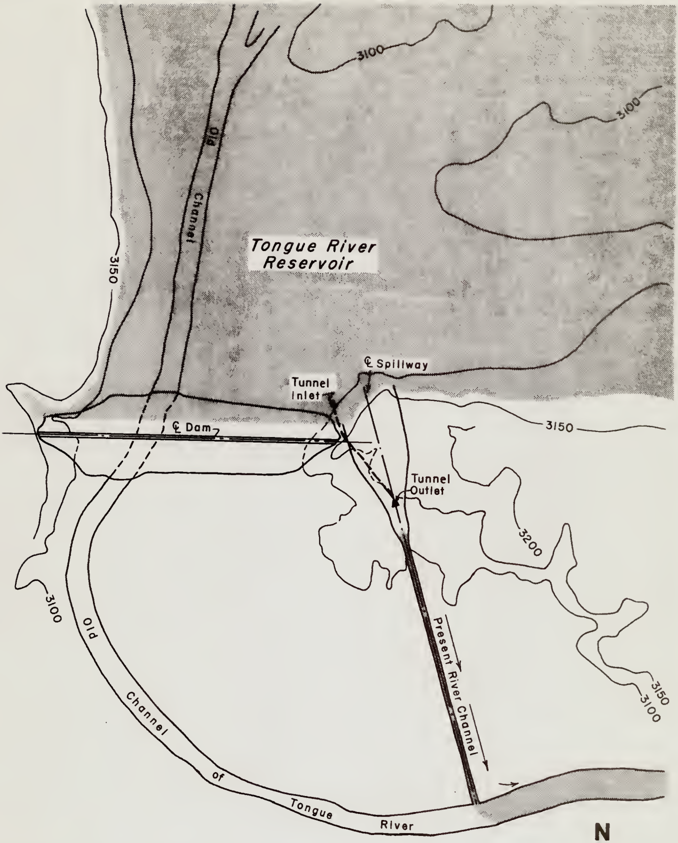


LOCATION MAP



VICINITY MAP

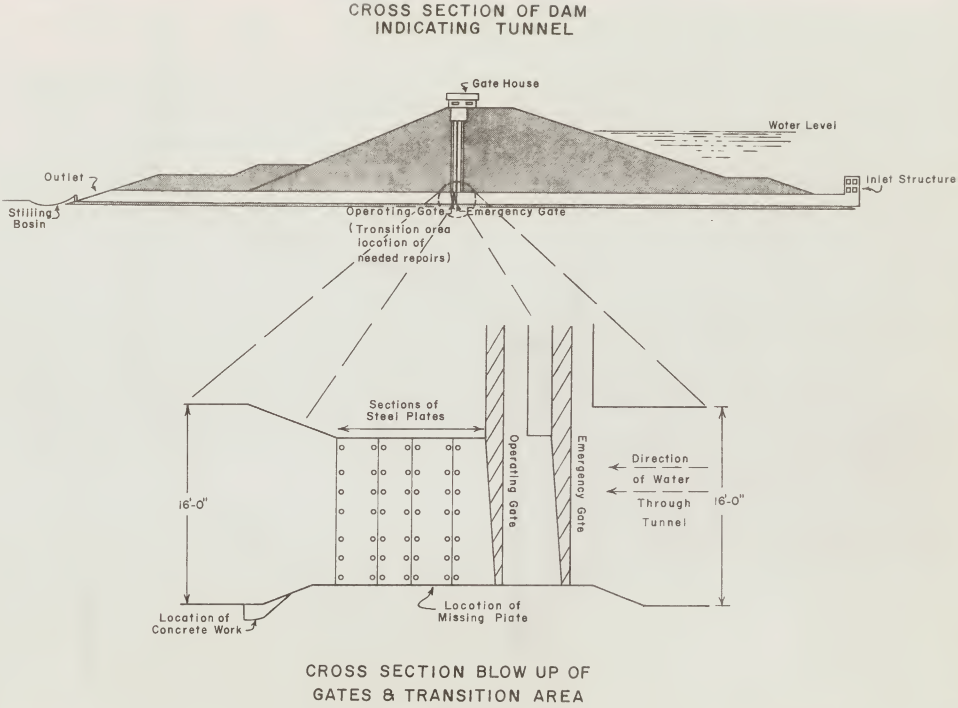
Figure I



*(Water Resources Division Datum See Text)

TOP VIEW

Figure 2



CROSS SECTION OF DAM INDICATING TUNNEL

CROSS SECTION BLOW UP OF GATES & TRANSITION AREA

Figure 3

II. DESCRIPTION OF PROPOSED ACTION

History

Major repairs have been made to the dam in the past, including:

1. Seepage control in 1940, 1951 and 1965.
2. Spillway repair in 1951.
3. Replacing gate control cables in 1958.
4. Riprapping channel below spillway in 1962.
5. Major repair to operating gate in 1970.

In 1968, a comprehensive engineering study was made of the project by Bechtel Corporation, an engineering firm of San Francisco. The purpose of this study, which was contracted by the Department, was to obtain recommendations for additional development of the Tongue River. Bechtel's proposals included increasing the height of the present dam or building a new dam downstream from the present structure.

An early 1973 Department report indicated that the dam was being carefully operated to avoid the necessity of using the spillway, that there was a considerable amount of spalling (surface deterioration) around the outlet of the conduit through the dam, and that a large part of the floor of the spillway might need to be replaced. Also, the stability of the foundation for the spillway was found questionable.

Present Condition

During the annual inspection in October of 1973, repairs in the outlet tunnel immediately downstream of the operating gate of the dam were found necessary. The tunnel is a cast-in-place concrete pipe, 16 feet in diameter. The rectangular shape of the gate necessitates a transition area to the circular tunnel. The current problem with the Tongue River Dam is within the transition area. A large steel plate that protects the side wall of the transition has been washed away.

Additionally, the concrete floor of the transition area has begun to erode. This sort of damage results when a negative pressure is created by water flowing through the smaller gate opening into the large tunnel. Vapor cavities, which are essentially small vacuum areas, are produced by this negative pressure. These cavities ultimately callapse, and extremely high pressures develop which extend to the tunnel floor. As the water rushes into the cavities it tends to pull concrete, sand, and gravel particles away and thus erodes the strongest concrete. It is a fairly common problem with this type of gate, and repairs can be expected from time to time.

Since its construction in 1939, the spillway has been undermined by seepage. In certain areas, the supporting base of fill has been eroded away, and the net effect is that the spillway is merely acting as a bridge. Water flowing over the spillway creates vibrations that threaten further deterioration. The reservoir has, therefore, been operated in a manner that precludes general use of the emergency spillway. However, no repair of the spillway is intended at this time.

Objectives

Experience with similar dams has shown that if this type of outlet tunnel repair is not made quickly, deterioration occurs at an increasing rate. Consequently, repairs become more costly and require more time to complete. Further, as the repairs are postponed, the threat to life and property becomes more imminent.

Proposed Action

With these considerations in mind, the Department has determined the action that should be taken. The proposed action will involve repair of the eroded concrete and replacement of the missing steel plate. In order to gain access to the transition area and undertake the repair operation, it will be necessary to close the gate and dewater the tunnel. This action will essentially stop all downstream flow of the Tongue River for some 20 miles, to the point where Hanging Woman Creek enters the Tongue near Birney.

Problems

Providing flow immediately below the dam will be difficult, for the dam was constructed without a by-pass tunnel for use when the main tunnel is inoperable. The problem is further compounded by the fact that the main tunnel outlet is located at the base of the spillway. Unless extensive diking were established upon the spillway for diverting flows away from the outlet, it would not be possible to undertake the repair effort. Additionally, the safety of any diking is doubtful in that the reservoir water level could rise and wash out or overflow any temporary embankment.

A further consideration relates to the poor condition of the emergency spillway itself. Although the structure is safe for short periods of use, there is little likelihood that it could be used for the length of time necessary to rectify the current problems within the tunnel.

Duration and Timing of Proposed Operations

The scheduled repairs would require a maximum of five weeks to complete, depending on the alternative chosen. This would allow time to procure and transport the necessary equipment to the job site, close and seal the gates, prepare for repairs in the tunnel (lights, air line, etc), place and harden the concrete, weld the steel plates and dismantle the equipment. A tentative work schedule illustrating the estimated time needed to complete the various phases is shown in Figure 4.

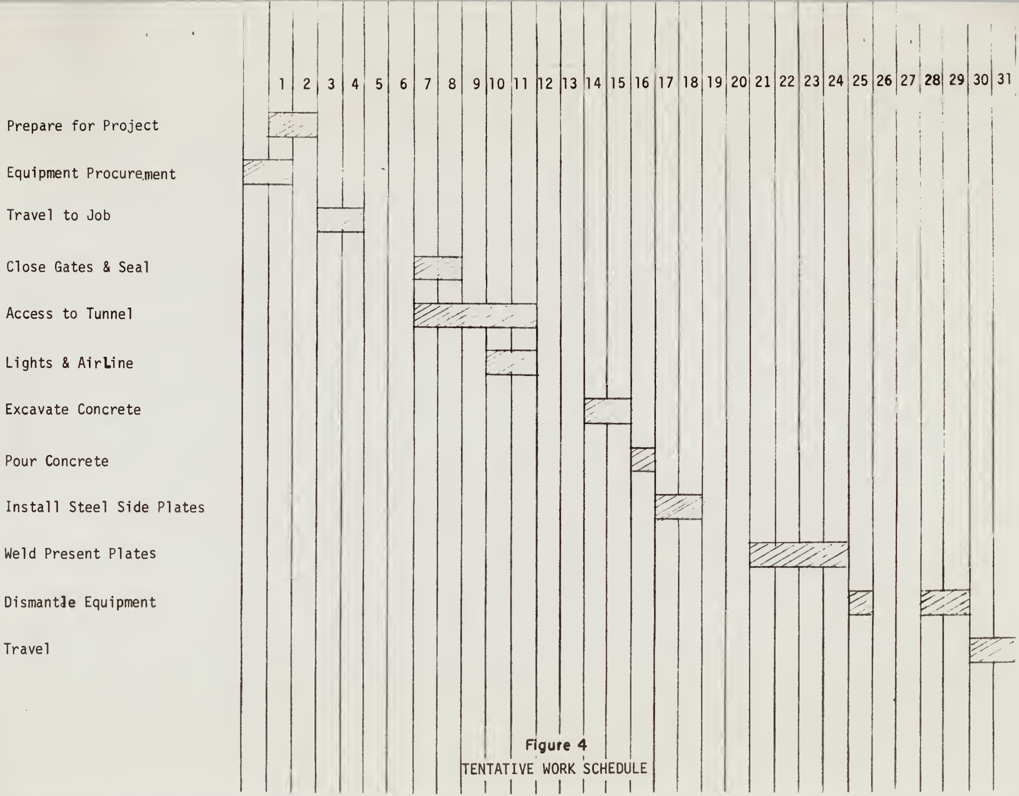


Figure 4

TENTATIVE WORK SCHEDULE

III. EXISTING ENVIRONMENT

Climate (USDI, USDA, 1973)

Climate of the area, as is typical of the Northern Great Plains, is generally considered semi-arid. Rapid and violent changes in weather are common. The maximum temperature recorded at Birney was 107°F; the minimum temperature was -45°. Annual precipitation at Ashland ranges from 9 to 24 inches. The average is 16 inches, more than half of which occurs from April through September. The growing season at Ashland ranges from 120 to 130 days and is about 10 days shorter at Birney and Decker. In the surrounding high country it is about 100 to 110 days.

Summer thunderstorms with hail and high winds are frequent, with hot, dry periods common throughout the summer. Winters are cold, and, at times, snowfalls are heavy. Blowing snow creates ground blizzards and drifts, leaving range open and fields bare.

Vegetation (USDI, USDA, 1973)

The Tongue River Basin has a number of major vegetation associations. Among these are:

1. The Grassland Association is found on the upland plateau and divides at higher elevations. Soil textures range from medium to course. Some of these grasslands are under cultivation.
2. The Big Sagebrush-Shrub Association is dispersed throughout the entire basin. It occurs in a variety of exposures and soil types but primarily at low to middle elevations.
3. The Ponderosa Pine Association is found on north, west and southwest facing slopes. Within long narrow valleys, it occupies all exposures.
4. The Pine Woodland Association occupies a variety of sites but is generally found on rocky, steep, southerly exposures.
5. The Broadleaf Association is found mainly along perennial streams. Cottonwood, boxelder-ash and silver sagebrush are among the different types belonging to this association.

Hydrology (USDI, USDA, 1973)

Approximately 379,000 acre feet of water per year flows across the state line near Decker, Montana. Through irrigation and evaporation the net water loss is 2 acre feet per square mile of the drainage area between the state line and Miles City. The evaporation loss from the Tongue Reservoir alone is 4,000 acre feet per year. Drainage area of the Tongue River, including flatlands of Montana and Wyoming as well as the eastern side of the Bighorn Mountains, is 5,379 square miles. The major inflow to the Tongue River is a direct result of rainfall or snowmelt. There is very little year-around discharge from groundwater sources to streams, although the volume increases somewhat during the spring. The Tongue River flows into the Yellowstone River just west of Miles City, Montana.

The average flow at a location one-half mile below the dam (Station 3, Appendix A) is 449 cubic feet per second. Streamflow records from various other stations along the river are likewise shown in Appendix A. These figures have been established from 34 years of record compiled by the United States Geological Survey (USGS, 1973).

Water Rights

A water right was filed by the State Water Conservation Board in Rosebud County on April 19, 1937, for all unappropriated water of the Tongue River. The Board filed another water right in Big Horn County on January 31, 1938, for all unappropriated water of the river. Since the Tongue River flows through Wyoming as well as Montana, it is covered by the Yellowstone Compact.

Aquatic Resources

Reproducing fish populations below the dam include brown trout, northern and walleye pike, sauger, small mouth and rock bass, black and white crappie, and several species of sucker and other rough fish. During the fall brown trout spawn in this river. All other species spawn during early to mid-spring. Rainbow trout have been planted, and there is evidence of overwinter survival. Snapping and soft-shell turtles are found throughout the river area. The minimum flow necessary to sustain the aquatic life for a short period has been estimated at 45 cfs.

In general, however, there is a lack of comprehensive data upon the Tongue River fisheries resource. Toward gaining an understanding, several comprehensive studies were initiated early in 1974 by the Montana Department of Fish and Game, the University of Montana, and the Bureau of Sports Fisheries and Wildlife concerning fish and wildlife ecology and assessments of in-stream values. The research,which will be completed by the fall of 1975, is expected to establish the baseline data needed to initiate a comprehensive streamflow management program.

The Tongue River has been selected for these intensive studies in part because this river appears to exhibit many of the fishery parameters of the Yellowstone. In conjunction with analyses of the Yellowstone and other tributary watersheds, certain results from the Tongue River studies can be readily transferred to the larger Yellowstone. A further reason for selecting the Tongue involves its marginal nature and thus its vulnerability.

Wildlife (USDI, USDA, 1973)

Most prominent among the big game species are the mule and whitetail deer and antelope. The population of these animals is dependent upon the availability of winter forage, and food habitat studies in eastern Montana have shown that silver sagebrush is the most important winter forage plant. The availability of sage in the Tongue River Basin appears sufficient for normal winters but not for severe winters when periodic die-offs occur.

A variety of grouse have been observed in the area along with pheasants, partridge, and wild turkey. The nesting waterfowl include ducks, geese, and great blue heron. Both golden and bald eagles have been sighted on National Forest land northeast of the reservoir. In addition to these species, more than 40 non-game birds have been identified by a local ornithologist.

Among the fur-bearers known to exist in the Tongue River area are coyote, muskrat, beaver, badger, bobcat, skunk, mink, raccoon, and fox. The size and condition of these populations has not been determined.

Recreation

The major recreational activities in the area are fishing and hunting. However, the Tongue River is the only flowing stream in the area where non-fishing recreation occurs. River floating is done below the dam, while the reservoir itself provides boating, water skiing and swimming.

Agriculture (USDI, USDA, 1973)

A limited amount of land, confined to plateaus along the river or the broader valley bottoms, is used for hay production. The hay produced in this region is generally used locally rather than being sold as a cash crop. The local production of hay has contributed significantly to stabilizing the economy of the predominately livestock-producing area.

Dryland farming is practiced to some extent but is mainly limited to small grains such as wheat and barley. Dryland hay production is not a reliable source. One cutting of hay is all that can be expected most years, whereas in irrigated areas two or three cuttings are possible. Of the 20,553 irrigable acres, 9,017 are in fact irrigated.

IV. ALTERNATIVES

Operation and maintenance of water resources development projects administered by the Department of Natural Resources and Conservation are normally carried out by local water users associations with the technical guidance of the Department. The associations are required to finance the projects and all major maintenance activity; operational policies are carried out with the approval and direction of the Department.

The Department has evaluated a variety of alternative courses of action for the Tongue River repair effort ranging from that of doing nothing to the construction of a by-pass tunnel as a means to maintain flow levels. Further, the various options have been evaluated from a perspective of time. The advantages and disadvantages of each option are presented as well as the monetary costs of implementation. Construction of a new dam was not considered a feasible alternative. It would take nearly 10 years to implement such an action, during which the present damage would worsen and the probability of failure would escalate drastically.

The Department's decision upon the final course of action is yet to be made. That determination will be partly on the basis of comment received subsequent to circulation of this impact statement, the results of another inspection of the dam to be conducted on October 3, 1974,and the desires of the Tongue River Water Users Association.

The repair effort has been scheduled for this fall; however, if the damage has not worsened substantially since last years evaluation, there may be an opportunity to forestall the action until spring 1975 or, at the very latest, during the fall of the same year. If it is necessary to repair the dam this fall (1974), there will be little likelihood of supplying any downstream flow. Equipment and funding necessary to implement any action other than closing the gates and making the repairs are not available.

Alternatives Relating to Time of the Action

Alternative 1 -- Make the proposed repairs in the spring.

A. Advantages

1. Because the Tongue River receives considerable flow from tributary streams in the spring, flow would exist downstream from the dam while the gates are closed. Thus, enough water might be naturally provided to maintain the fisheries.

2. Groundwater recharge of the river would be greater.

B. Disadvantages

1. High runoff can occur during the spring. The use of the emergency spillway, as previously noted, is risky and should be avoided. Therefore, as runoff increases and the reservoir approaches the spillway elevation, the gates will have to be opened to pass the high flows. If the gates were opened before the repairs were completed, all repair work accomplished up to that time would be lost, and the repairs would have to be postponed. This could create a substantial additional expense.

2. Access to dam in the spring is difficult due to poor road conditions.

Alternative 2 -- Make the proposed repairs in the summer.

A. Advantages

1. Better working conditions would be encountered.

2. Access would be improved.

B. Disadvantages

1. Irrigation would be interrupted.

2. Fishery damage would be more than if the repairs were made at any other time of the year unless substantial flows are provided by other means, for any low flows would be used up by irrigators downstream.

Alternative 3 -- Make the repairs in the fall.

A. Advantages

1. Inflow to the reservoir is normally stable and fairly low, reducing the risk of needing to release water through the gates while the repairs are taking place.

2. The fall of 1974 may be the first reasonable opportunity to make the repairs, limiting the amount of damage to its current level.

B. Disadvantages

1. Tributaries below the dam provide little water during the fall, so the Tongue River would be significantly affected by closing the gates at this time of the year.

2. Brown trout spawn in the fall and would therefore lose the reproduction of that year.

Alternative 4 -- Make the proposed repairs in the winter.

A. Advantages

1. Stored water is not needed for irrigation.

B. Disadvantages

1. The river below the dam may freeze. When the water is returned to the stream, the ice would break up due to the increased stream flow, forming ice jams which could cause flooding.

2. Working conditions would be difficult in cold weather and result in more time being required for repairs.

3. Tributary flow would not be available for the fishery.

4. Access would be more difficult.

5. Total freeze up of river would eliminate aquatic invertebrates and fish.

Alternative 5 -- Postpone repairs.

A. Advantages

1. There would be less immediate impact on the fisheries.

2. Current fishery studies would be undisturbed.

3. Future developments such as new methods and materials could lessen the time and/or cost required for the repairs.

B. Disadvantages

1. If damage increases, a much longer time would be required.

2. If damage increases repairs would be more costly.

3. Control of the dam could be lost in a few years, thus eliminating the benefits provided.

4. The dam may eventually fail, causing environmental damages and possible loss of life and property.

Alternatives Relating to Type of Action

Alternative 1 -- Close the gates and maintain a downstream flow during repair operations by allowing water to flow over the spillway.

A. Advantages

1. Further deterioration of the tunnel would be avoided.

2. Cost of repairs would not have to include pumps or structures necessary to maintain the downstream flow.

3. Continued downstream flow of the water would be possible as long as there is inflow into the reservoir.

B. Disadvantages

1. Allowing flow over the spillway is hazardous due to the poor condition of the structure. In the past the reservoir has been operated in a manner that precludes the flow of water over the spillway and thus avoids further deterioration of the structure.

2. Unless elaborate dikes or piping were set up, water from the spillway would back up into the tunnel, preventing access. Rising water

could cause sudden failure of the dikes, creating a hazard to the people doing the repair in the tunnel. The construction of dikes or pipes on the spillway would be difficult and expensive.

3. The reservoir would have to fill before the gates could be closed. Depending on the inflow to the reservoir, considerable time could elapse before repair work could commence, especially if repair during the fall were intended.

Alternative 2 -- Close the gates and maintain a limited downstream flow by pumping water over the spillway.

A. Advantages

1. Further deterioration of the tunnel would be eliminated.

2. Continued flow of the water downstream would be possible, although not as high as normal. The actual amount provided would depend upon available funding and pumping equipment.

3. The spillway would be subjected to less wear than under the preceding alternative.

B. Disadvantages

1. High costs would be incurred in acquiring and operating the pumping systems. The costs of operating different pumping systems and supplying the minimum flow for fisheries (45 cfs) are shown in Appendices B through F. Including the expense of a channeling structure over the spillway, (see Appendix F) the costs are:

a. Purchase and operate 6 Crisafulli pumps: $65,819
b. Purchase and operate 1 turbine pump: $49,344
c. Purchase and operate 2 turbine pumps: $62,580
d. Rent and operate 6 high lift turbine pumps: $52,307

2. The pumping system would be in the way, possibly making the repair operation more difficult.

3. More time would therefore be necessary for completion of the repairs.

4. Depending on the time of year, the reservoir may be low when the repairs are being made. This could necessitate a high lift of 30 to 40 feet measured from the reservoir water level to the spillway crest elevation.

Alternative 3 -- Close the gates and maintain downstream flow by cutting a small, temporary hole in the gate and discharging some water through the tunnel by means of a small pipe.

A. Advantages

1. Further deterioration of the tunnel would be reduced.

2. Continued flow of the water downstream would be possible, although it would be sufficient for only minimal maintenance of fisheries.

3. The spillway would not be needed for maintaining downstream flow.

B. Disadvantages

1. High cost would be encountered in installing and removing the pipe. As shown in Appendix G the cost of this alternative has been estimated to be $48,765.

2. The pipe would be in the way of repair operations.

3. Time to complete the repairs would be extended.

4. Installation could create a safety hazard.

Alternative 4 -- Breech (essentially remove) the dam.

A. Advantages

1. A river environment would replace the reservoir.

2. The repairs and concomitant cost would not be necessary.

3. Flows needed for the fisheries could be maintained until the breech is completed.

B. Disadvantages

1. Much of the downstream irrigation would be eliminated, thus creating a hardship upon a portion of the agricultural community.

2. The stream would be dewatered in several places by the remaining irrigators.

3. There would be a loss of recreational use of the reservoir.

4. State income from sale of water would be reduced.

5. The fishery in Tongue River would be reduced.

Alternative 5 -- Construct an additional outlet in the dam.

A. Advantages

1. This would be a long-term solution in that it could be used to supply water downstream whenever future repairs are needed.

2. Water would be supplied downstream while the existing outlet is being repaired.

3. Another outlet would provide an additional safety factor for the spillway.

B. Disadvantages

1. Constructing the additional outlet would be expensive, roughly estimated at $928,577 (See Appendix H).

2. In order to undertake this action, the reservoir would have to be drained completely, thus causing economic loss to the farmers while the outlet is being constructed.

3. Fisheries in the reservoir would be destroyed.

4. Recreational opportunities at the reservoir would not be available during the construction process.

5. During the operation, the river would revert to its natural flow and could dry up.

6. Extremely difficult working conditions would be encountered in that the fill material comprising the dam would be saturated.

7. The existing outlet could deteriorate to the point of being in danger of failing while the reservoir was being drained.

Alternative 6 -- Do nothing

A. Advantages

1. The repairs and concomitant cost would be unnecessary.

2. There would be less of an immediate impact on the fisheries.

B. Disadvantages

1. Control of the dam would eventually be lost.

2. The safety of life and property could no longer be guaranteed to any degree.

V. ENVIRONMENTAL IMPACT OF PROPOSED ACTION

Climate

The climate of the area will not change as a result of undertaking the proposed action.

Vegetation

The major vegetational associations discussed are not likely to suffer as a result of the action. A small amount of seepage from the dam (estimated at 2 cfs) will preclude drying of the river bed. Ground water, which probably comprises an adequate supply for vegetation, will not suffer any unusual draw-down because of repair. During spring, flows from intermittent streams, in concert with ground water, should be adequate for any water-dependent riparian vegetation. If repairs are made during periods of dormancy, the chances of a significant adverse impact are greatly reduced.

Hydrology

Tributaries to the Tongue River provide sparse amounts of water during the summer, fall and winter. Therefore, the entire stretch of the river below the dam will be affected by opening and closing the gates during this time of year.

Runoff from the intermittent tributaries in the spring is probably sufficient to supply an adequate flow to the Tongue River below the dam. High spring runoff into the reservoir is potentially dangerous if the gates are closed since the reservoir may rise rapidly and use of the emergency spillway may be necessary.

A combination of high spring runoff and flash storms could greatly endanger the dam, as well as the safety of the people living downstream, if provisions are not made to store the increased amount.

Aquatic Resources

As a result of a study made in conjunction with the Westwide Water Study (USDI, 1974), the Montana Department of Fish and Game recommended necessary flows for maintaining the survival of fish. On the basis of the average flow one-half mile below the dam of 449 cfs, it has been determined that:

1. Thirty percent (30%) of average flow, or 135 cfs, is sufficient for a good fishery.

2. Twenty percent (20%) of average flow, or 90 cfs, is adequate for the survival of fish and related aquatic life.

3. Ten percent (10%) of average flow, or 45 cfs, will allow for only the short-term (up to 30 days) survival of fish.

The flow immediately below the dam during most years has been maintained above the critical 45 cfs level. However, average daily flow of the Tongue River downstream from the dam has been below the critical level at least six times since 1941. The flow at Miles City is often below 45 cfs and occasionally has remained considerably below this level for several days. These low flows, however, have not persisted as long as the proposed repair period. The flow at the two streamflow gauges above the dam has dropped to less than 45 cfs in about one-third of the years of record and below 90 cfs in about half of these years. The stability of the fishery in this river has apparently improved with the construction and subsequent operation of the Tongue River Dam, although it remains marginal.

The season during which the repairs are made is important from a fisheries standpoint. Spring is recognized as the best time in that cool water from surface and ground-water sources will supplement any flows that can be made available. The magnitude or duration of any impact is largely speculative until the current fish ecology studies are complete. Fall is the next best season, although stream recharge from other sources is markedly reduced. Brown trout are the only species that spawn in the fall (October 1st to mid-November), and therefore no flow or less than the critical flow will affect the brown trout population. This would also be largely the case with other species in the river. Winter poses problems with deep freezing if flows are not adequate and must therefore be considered poor from a fisheries standpoint. Summer is the worst time to undertake the repairs, since reduced flows and increased temperatures limit the chance for fish survival.

Providing downstream flow by various alternative methods presents different impacts upon the fisheries resource.

Pumping the minimal acceptable flow over the dam structure would be sufficient for the survival of the fishery during the repair period. This flow (45 cfs) would provide sufficient oxygen for the pool areas as well as sustain most aquatic flora and fauna.

In the event it were not possible to provide a flow over, through or around the dam, the aquatic life would be dependent upon seepage from the dam. If the repairs were made in the spring, the flow would be supplemented by surface and ground-water sources. There is a possibility that the reservoir is recharging springs in the river area that likewise can afford supplemental flow. Limiting flows to this level may not necessarily destroy the fish resource, although, due to greater oxygen depletion, the chances for survival would be reduced significantly. Further, low flows would eliminate the invertebrates of riffle areas, but they would repropogate rapidly when a normal flow regime is reintroduced.

A final consideration relates to the impact on the ongoing fisheries research of altering normal stream flow. Any action taken prior to fall 1975 will largely negate these efforts. Recognizing this fact, the Department will endeavor to postpone action until the studies are complete. Only if the dam structure and safety of area residents is threatened by postponement, will the action be undertaken sooner.

Wildlife

The effect of the repair should have little impact on the many species of wildlife that exist in the Tongue River Basin. Sufficient pools of water would remain if the flow ceased for a short while. Low flows would provide a more than ample supply of water for the wildlife.

Dewatering of the river in the spring or fall would have some impact upon migrating waterfowl, particularly mallard ducks and Canadian geese. A late spring drawdown would affect the nesting waterfowl population.

Recreation

During any repair operation the reservoir would begin to take on water, and the discharge from the dam would be far less than average. With the river being low, fishing, the major recreational activity, would be hampered. Fishing would be poor from the dam to the point near Birney where Hanging Woman Creek enters. It is also obvious that river floating would be suspended during the repair period. Despite the rising water in the reservoir, recreational activities there could continue normally. Hunting of migratory waterfowl would be limited if the repairs were undertaken in the fall.

Agriculture

Repair made in late fall or winter would not harm the agricultural activity in the area. For the most part the irrigation and harvesting seasons would be over, and the farmers in the area would suffer no loss due to low flows. There would be sufficient water for livestock purposes.

Spring or summer repairs might jeopardize irrigation during the growing season, and its loss would have a serious effect on those who are dependent on this reservoir for their irrigation supplies.

VI. RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

Repair of the eroded concrete and replacement of the missing steel plate would require closure of the gates and dewatering of the tunnel. The time allotted for this repair has been estimated at five weeks.

The closure of the gates will have a number of short-term effects. Depending upon the season chosen for the repairs, a low flow or no-flow situation can be expected to alter the aquatic resource. The invertebrates and lower elements of the food chain, especially in the riffle area, could be lost. However, in that they are largely able to repropogate quickly, the long-term productivity of the resource should not be changed drastically.

The fish will collect in pools and remain alive as long as there is sufficient oxygen in the water and the temperature does not change radically. The extent to which the long-term productivity of the fisheries resource will suffer depends upon the availability of supplemental ground-water and surface flows. A precise estimate of the long-term consequences of the various alternatives is not possible at this time. There are estimates of flows necessary to sustain the fisheries; however, any real determination must be based upon results of the current fisheries studies.

A primary downstream use of the water is irrigation. A limited amount of land along the river is being used for hay production. Therefore, a low or no-flow situation would affect the citizens during the irrigation season, but hopefully it will not be necessary to make the repairs during that time.

The long-term benefit of the proposed repair would be the continued safe operation of the dam. The water users would again have the use of the controlled river flow for irrigation. The aquatic life in the river would again be regenerated by the controlled flow.

Any action that necessitates drying or substantially altering the level of the reservoir will certainly impact that fishery as well as the agricultural industry. The impact would be significant although likely short-term.

If the alternative of no action were pursued, the consequences would be drastic and long-term. In the absence of repairs, the reservoir would ultimately be drained and the dam breeched. Should this be allowed to happen, there would be significant erosion and sedimentation problems. The river would return to its natural flow, and the present fisheries resource would be reduced. Equally significant, the productivity of a most important industry, agriculture, would be reduced. Those lands whose productivity has been improved by the availability of stored water would, of necessity, revert to a lesser productive use.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The concrete and steel once committed to the repair will be rendered both irreversible and irretrievable. The quantity of concrete used to fill the eroded tunnel area is not significant. The steel to be used will be a plate 4 foot by 12 foot in area and one-half inch thick. This plate will be welded in the same location as that which was pulled off and washed away. Welding will also be done on the other steel plates in an effort to avoid a recurrence of the problem. The fossil fuels necessary to implement any pumping or reconstruction alternative would comprise a furthur irreversible resource commitment.

Despite any losses that may occur in the river, the river itself is a biological entity, capable of regeneration. This ability to reproduce indicates there is generally no irreversible commitment of the river. However, the Tongue River contains the only reproducing population of rock bass within Montana. In contrast with other fish populations that may be reduced or eliminated by the action, it is not possible to restock the rock bass. Consequently, if a loss of this population occurs, it must be considered an irreversible commitment of a resource.

VIII. LITERATURE CITED

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APPENDIX A

TONGUE RIVER STREAMFLOW RECORDS

STATION 1

TONGUE RIVER at STATE LINE, near DECKER, MONTANA

LOCATION: NE¼ Section 33, Township 9 South, Range 40 East, Big Horn County, 1 mile North of Wyoming-Montana state line, 1.4 miles Southeast of Decker.

AVERAGE FLOW: 493 cfs*; 12 year record (1960 - 1972)

LOWEST RECORDED FLOW: 3.9 cfs, August 23, 1961

OTHER LOW FLOW PERIODS:

PERIOD	FLOW (cfs)
August 7 to August 31, 1974	82-98
August 20 to September 8, 1970	64-95
July 11 to August 21, 1966	20-90
August 25 to September 25, 1966	49-92
August 2 to September 1, 1963	72-99

MINIMUM AVERAGE DAILY FLOW:

YEAR**	FLOW(cfs)	YEAR**	FLOW (cfs)
1972	150	1966	20
1971	153	1965	126
1970	100	1964	88
1969	64	1963	72
1968	118	1962	110
1967	90	1961	5

STATION 2

TONGUE RIVER near DECKER, MONTANA

LOCATION: SE¼ Section 22, Township 9 South, Range 40 East, Big Horn County, 2 miles north of Wyoming-Montana state line about 3 miles upstream from high water line of Tongue River Reservoir.

AVERAGE FLOW: 384 cfs*; 10 year record (1928 - 1938)

LOWEST RECORDED FLOW: 2.9 cfs, August 20, 1934

OTHER LOW FLOW PERIODS:

PERIOD	FLOW(cfs)
August 1 to August 31, 1935	33
October 1 to October 31, 1934	20
September 1 to September 30, 1934	13
August 1 to August 31, 1934	5
July 1 to July 31, 1934	17

MINIMUM AVERAGE DAILY FLOW:

YEAR**	FLOW(cfs)	YEAR**	FLOW(cfs)
1938	86	1932	34
1937	47	1931	8
1936	26	1930	Not Available
1934	3	1929	Not Available
1933	38	1928	Not Available

STATION 3

TONGUE RIVER at TONGUE RIVER DAM near DECKER, MONTANA

LOCATION: NE¼ Section 13, Township 8 South, Range 40 East, Big Horn County, 0.5 mile downstream from dam.

AVERAGE FLOW: 449 cfs*; 33 year record (1939 - 1972)

LOWEST RECORDED FLOW: 0 cfs, November 12-13, 1969

OTHER LOW FLOW PERIODS:

PERIOD	FLOW(cfs)
April 26, 1973	5
April 24 to April 25, 1972	47
October 9, 1971	19
November 4 to November 6, 1969	47-80
February 27 to March 1, 1968	89-90
October 4 to December 10, 1966	59-99
October 12 to December 15, 1963	46-62
October 13 to November 22, 1961	80-83
March 11 to March 31, 1955	66-97

MINIMUM DAILY AVERAGE FLOWS:

YEAR**	FLOW(cfs)	YEAR**	FLOW(cfs)	YEAR**	FLOW(cfs)
1972	150	1961	5	1950	92
1971	153	1960	66	1949	61
1970	100	1959	145	1948	150
1969	64	1958	86	1947	132
1968	118	1957	45	1946	99
1967	90	1956	37	1945	89
1966	20	1955	42	1944	55
1965	126	1954	49	1943	69
1964	88	1953	80	1942	48
1963	72	1952	49	1941	28
1962	110	1951	6	1940	Not Available
				1939	Not Available

STATION 4

TONGUE RIVER near ASHLAND, MONTANA

LOCATION: Near center of Section 2, Township 1 South, Range 44 East, Rosebud County, 2 miles upstream from Beaver Creek, 13 miles north of Ashland.

AVERAGE FLOW: 510 cfs*; 7 year record (1966 - 1972)

LOWEST RECORDED FLOW: 50 cfs, November 8, December 1-3, 1966

OTHER LOW FLOW PERIODS:

PERIOD	FLOW(cfs)
November 27, 1969	80
November 15, 1969	110
November 22 to December 13, 1966	50-95

MINIMUM DAILY AVERAGE FLOW:

YEAR**	FLOW(cfs)	YEAR**	FLOW(cfs)
1972	110	1968	130
1971	100	1967	50
1970	80	1966	Incomplete records
1969	170		

STATION 5

TONGUE RIVER at MILES CITY, MONTANA

LOCATION: SE¼ Section 23, Township 7 North, Range 47 East, Custer County, 4 miles South of Miles City, 8 miles upstream from mouth.

AVERAGE FLOW: 423 cfs*; 29 year record (1938 - 1941 and 1946 - 1972)

LOWEST RECORDED FLOW: 0 cfs, July 9-19, August 13-14, and September 28, 1940

OTHER LOW FLOWS:

PERIOD	FLOW(cfs)
August 18 to August 25, 1970	80-99
November 19, 1969	70
December 20 to December 22, 1967	90
September 19 to November 14, 1966	31-95
May 3 to May 13, 1966	65-99
April 21 to April 26, 1966	51-58
September 16 to November 24, 1963	21-92
July 25 to August 21, 1963	10-80
July 28 to August 5, 1962	35-99
November 17, 1961	15
October 18 to November 7, 1961	45-95

MINIMUM DAILY AVERAGE FLOWS:

YEAR**	FLOW(cfs)	YEAR**	FLOW(cfs)
1960	4	1950	11
1959	55	1949	4
1958	17	1948	64
1957	29	1947	32
1956	5	1942 - 1946	No Record
1955	5	1941	0
1954	5	1940	Not Available
1953	9	1939	Not Available
1952	69	1938	Not Available
1951	38		

* Cubic Feet Per Second (cfs) -- a flow rate of 448 gallons per minute.

** All years are "Water Years," from October 1 through September 30.

APPENDIX B

PUMPING USING CRISAFULLI PUMPS

Pump Data

16" Dia. High Lift Crisafulli Pump*

HEAD	CAPACITY
10 feet	10,560 gpm
20 feet	7,120 gpm
30 feet	3,330 gpm
38.3 max.	-0-

Average Storage Elevation of Tongue River Reservoir for Period October-November	3110 feet
Spillway Crest Elevation	3130 feet
Head Loss Due to Tubing (estimate)	10 feet
Total Head of Pump	30 feet

Therefore: 3,330 gpm can be pumped

From Fish and Game minimum Streamflow requirements are: 45 cfs or 20,196 gpm

No. of Units Needed:
20,196 gpm/3,330 gpm/unit = 6.06 Units

Single Pump Unit

Pump Cost

Cost of one 16" Dia. Crisafulli Pump*	$ 2,800

Operation and Maintenance

Rent on 100 hp Farm Tractor*for 30 Days $1,000

Fuel consumption 8 gal/hr**
Diesel fuel @ $0.35/gal (cost as of July 19, 1974)
30 W oil @ $2.00/gal (cost as of July 19, 1974)
Oil Filters @ $2.50/filter (est. cost)

Cost of Fuel for 30 Days

8 gal/hr x 24 hr/day x 30 days/month x $0.35/gal $2,016

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* Crisafulli Pump Company Price Sheet April 29, 1974, and Performance Chart May, 1, 1974

** ASAE 1974 Yearbook, Nebraska Tractor Test Data 1974 Model 4430 Diesel John Deere.

Cost of Oil Changes for 30 Days			
Oil change every 100 hrs (recommended service frequency) 2 filters for tractor 2.5 gal/oil per tractor			
24 hr/day x 30 days/month x 1 oil change/100 hrs x 2.5 gal/tractor x $2.00/gal = $36.00/tractor/month for oil			
7.2 oil change/tractor/30 days x 2 filters/change x $2.50 filter = $35.00/tractor/month	$ 71		
		$ 3,087	
Cost of Accessories			
Cost of 150 ft of 16" Transmission Butyl Tubing @ $582.00/50 ft.		1,746	
Total Cost for 1 Pump for 30 Days		$ 7,633	
Cost of Multiple Units			
Cost of six pump units for 30 days			
6 units x $7,633/unit/30 days=			$45,798/month
Labor Cost			
Labor for Pumping for 30 Days			
3 men/day x 8 hrs/man x $10/hr x 30 days/man =	7,200/month		
Subsistence @ $15/day/man x 3 man/day x 30 day/month=	1,350/month		
Travel time @ $10/day/man x 3 men/day x 30 days/month =	900/month		
Cost for Labor to Operate Pump			$ 9,450/month
Cost of Supplying 45 cfs for 30 Days			$55,248

COST ADJUSTMENTS

Cost of Supplying 45 cfs for 30 Days	$55,248
10% for Engineering Costs	5,524
20% for Contingencies	12,154
Cost for New Pumps	$72,927
Salvage Value - 50% of New Cost	8,400
Total Cost Using Six Crisafulli Pumps	$64,527

All labor prices are based on contract prices to the owner.

APPENDIX C

PUMPING COST FOR ONE TURBINE PUMP UNIT

Pump Data

Need 45 cfs - 20,196 @ 50 ft* Head

Model 24 x 20 x 24 H Aurora Pumps

Mixed Flow
880 rpm
HP required - 300 Hp
24" Flanged Discharge, 28" plain

Pump Cost

Complete Pump w/ten foot lift pipe	$4,860	
Right Angle Drive	8,775	
300 Hp Diesel Motor (Cummings) w/o Fuel Tank and Batteries	10,544	
Fuel Tank and Batteries	300	
Turbine Pump (complete)		$24,479

Operation & Maintenance

Cost of Fuel for 30 Days		
10 gal/hr x 24 hr/day x 30 days/month x $0.35 =	$2,520	
Cost of Oil Changes for 30 days Assume 200 hrs/oil change		
4 Oil changes/month x 2 filters/oil change x $2.50/filter = $20/month		
24 hrs/day x 30 days/month x 1 oil change/200 hrs x 3 gal oil/oil change x $2.00/gal = $22		
Cost for Oil Changes	42	
Cost for Operation and Maintenance		$ 2,562

*Estimated total head including pipe friction

Cost of Accessories			
Discharge Line			
150 ft of 24" pipe @ $25/ft	$3,750		
Sump for Pump			
Cost includes sump, labor, and pump installation	5,000		
Cost for Accessories		$8,750	
Labor Cost			
Supervisor			
1 hr/day x 30 days/month x $22/hr	$ 660		
Laborers			
3 men/day x 8 hrs/man x $10/hr x 30 day/man	7,200/month		
Subsistence for 3 men/day x 30 day/month x $12.50/day	1,125/month		
Travel Time			
3 men/day x 30 days/month x $10/day/man	900/month		
Labor Cost for 30 Days		$9,885	
Cost of Supplying 45 cfs for 30 days			$45,676
10% for Engineering Costs			4,568
20% for Contingencies			10,048
Initial Cost with no Adjustment for Salvage Value			$60,292
Salvage Value - 50% of New Cost of Pump			12,240
Total Cost Using Single Unit Turbine Pumps			$48,052

APPENDIX D

COST FOR TWO TURBINE PUMPS

Pump Data

Need 45 cfs-20,196 gpm @ 50 ft* Head

2 - Model 18 x 15 x 18 LM
12, 000 gpm - 50 ft. head
Mixed flow
880 rpm
HP required - 200 Hp (for each Pump)
18" discharge

Pump Cost

Complete Pump	$ 3,321	
Right Angle Drive	4,590	
200 Hp Diesel Engine (Cummings) w/o fuel tank and batteries	8,233	
Fuel Tank and Batteries	300	
Total pump Unit Cost for one Pump	$16,444	
Cost of 2 Units @ $16,444		$32,888

Operation Costs

Cost of Fuel for 30 Days		
8 gal/hr x 24 hr/day x 30 days/month x 1 oil change/100 hrs x $0.35	$4,032	
Cost of Oil Changes for 30 Days		
4 Oil changes/month x 2 filters/oil change x $2.50/filter = $20/month		
24 hr/day x 30 days/month x 1 oil change/200 hrs = $21.60		
Cost of oil change for one pump = $41.60		
Cost of Oil Changes for Two Pumps	83	
Total Operations Costs		$4,115

*Estimated total head including pipe friction

Accessories Costs			
Discharge Line			
300 ft of 18" steel pipe @ $20/ft	$6,000		
Sump for Pump			
Costs includes sump, labor and pump installation @ $3,000/each	6,000		
Total Accessories Cost		$12,000	
Labor Costs			
Labor			
Supervisor, laborers, subsistences and travel time (taken from labor cost)		$9,885	
Cost of Supplying 45 cfs for 30 Days			$58,888
10% for Engineering Costs			5,889
20% for Contingencies			12,955
Initial Cost with No Adjustment for Salvage Value			$77,732
Salvage Value - 50% of New Cost of Pumps			16,444
Total Cost Using Two Turbine Pumps			$61,288

APPENDIX E

RENTAL OF PUMPS

Pump Data

Pacific Pumping Company (Rental Agency)
Portland, Oregon

10" Diesel will pump 3,400 gpm @ 50 ft.* Head

Pump Cost

Rental Rate @ $738/month		
Need 6 Pumps to supply 20,196 gpm		
6 Pumps @ $738/month	$4,428	
Freight on 5,000 pounds @ $10/100 = $500		
$500 x 6 pumps = $3,000 x Round trip	6,000	
Setup and Breakdown Time		
2 men for 6 days - 96 hrs @ $10/hr	960	
Cost for Rental of Pumps		$11,388

Operation and Maintenance

Fuel Costs		
Diesel @ 5 gal/hr		
30 day/month x 24 hr/day x 5 gal/hr = 3600 gal/month		
3600 gal/month/pump x 6 pumps = 21,600 gal/month		
21,600 gal x $0.35/gal	$7,560	
Oil Costs		
Taken from previous examples	250	
Operation and Maintenance Costs		$7,810

Accessories Costs

10" Pipe for discharge		
Need 150' x $10/ft = $1,500 x 6 pumps	$9,000	
Miscellaneous Materials	1,000	
Accessories Cost		$10,000

*Estimated total head including pipe friction

Labor Costs

Labor for Pumping for 30 days		
3 men/day x 8 hrs/man x $10/hr x 30 days/man	$ 7,200	
Subsistence @ $15/day/man x 3 men/day x 30 day/month	1,350	
Travel time @ $10/day/man x 3 men/day x 30 days/month	900	
Cost for Labor		$ 9,450
Cost for Supplying 45 cfs for 30 days		$38,648
10% for Engineering Costs		3,864
20% for Contingencies		8,502
Total Cost for Pumping		$51,015

APPENDIX F

CHANNEL STRUCTURE ON SPILLWAY*

Length From Spillway Crest to Outlet		
1108 bd ft of 2" x 12" @ $300/100 bd/ft	$330	
600 bd ft of 2" x 4" x 8' @ $190/1000 bd ft	114	
Miscellaneous Hardware	50	
Labor		
Supervisor 8 hrs @ $22/hr	176	
2 Carpenters 8 hrs @ $18.50/hr x 2 men	296	
Travel 1 day @ $10/day x 3 men	30	
		$ 996
Removal		
2 men for 1 day @ $18.50/hr		296
Total for Channel Structure		$1,292

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* The total cost for channel structure must be included in all pumping alternatives.

APPENDIX G

PIPE THROUGH TUNNEL

Pipe, 12" Valves, Wye, and Stands		$21,000
Ramp (Includes Materials & Labor)		5,000
Install Holes in Gate		
2 men, one day	296	
Materials	100	
Total Install Holes in Gate Cost		$396
Divers, 2 men for 2 hrs each @ $25/hr		100
Transportation		
Semi 420 miles @ $0.80/mile	$336	
2½ ton truck @ $0.65/mile 900 miles	585	
Transfer Cost 3 men x 1 day	450	
Loading Cost 3 men x 1 day	450	
Total Transportation Cost		$1,821
Installation		
Labor	$2,960	
Subsistence	250	
Travel	200	
Boom Truck $9.60/hr	230	
Supervisor	880	
Subsistence	663	
Travel	50	
Total Installation Cost		$5,233
Miscellaneous		
Rental on Welder @ $29.90/wk	$30	
Acetylene Cutting Outfit	5	
Welding Cable per 50' $2.00/hr/wk	8	
3/4" and 1" Air hose per 50' $5.30/wk	16	
Portable compressor $82.75/wk	83	
Miscellaneous Costs		$142

Removal Time for Pipe		
3 days x 4 men/day x 8 hrs/day x $18.50/day	$1,776	
Subsistence 4 men/day x 3 days x $12.50/man	150	
Travel time 4 men/day x 3 days x $10/day	120	
Divers 2 men for 2 hrs. each @ $25/hr	100	
Supervisor 3 days x 8 hrs/day x $22/hr	528	
Total for Removing Pipe		$2,674
Removal of Ramp		
Supervisor 2 days x 8 hr/day x $22/hr	$352	
2 men x 2 days x 8 hrs/day x $22/hr	704	
Subsistence 2 men/day x 2 days x $12.50/day	50	
Travel 2 men/day x 2 days x $10/day	40	
Cost for Removing Ramp		$1,146
Cost of Pipe through tunnel		37,512
10% for Engineering Costs		3,751
20% Contingencies		7,502
Total Cost Using Pipe Through Tunnel		$48,765

APPENDIX H

ADDITIONAL OUTLET

1 - Pivot Valve	$ 35,000
1 - Gate Valve	35,000
1 - Gate House	2,500
1 - Tower Structure	
$250\ \text{yd}^3\ @\ \$225/\text{yd}^3$	56,250
1 - Inlet Structure	
$25\ \text{yd}^3\ @\ \$200/\text{yd}^3$	5,000
1 - Outlet Structure	5,000
600 ft. of 4 ft. Concrete Pipe	18,000
Reinforcing Steel	
82,000 lbs. of 5/8" dia. @ $0.2328/lb.	19,090
Structural Steel	
15,000 lbs. @ $0.25/lb.	3,750
Structural Iron	
2,000 lbs. @ $0.25/lb.	500
Cutoff collars 4 @ $500 ea.	2,000
Miscellaneous Hardware & Fittings	3,000
Labor:	
Installing Gates-4 men/day x 30 days x 8 hr/day x $20/day	19,200
Installing Concrete Pipe-4 men/day x 30 days x 8 hr/day x $20/day	19,200

Excavation	
221,850 yd^3 @ \$1.00/yd^3	$221,850
Backfill Class C	
221,850 + 33,277 (15%) = 255,128 yd^3 @ \$1.00	255,128
Backfill Structural	
1,000 yd^3 @ \$3.00/yd^3	3,000
Total Cost for Labor and Materials	$703,468
10% for Engineering Costs	70,347
20% for Contingencies	154,763
TOTAL COST	$928,577